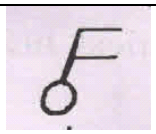
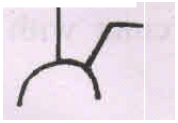
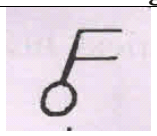
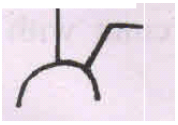
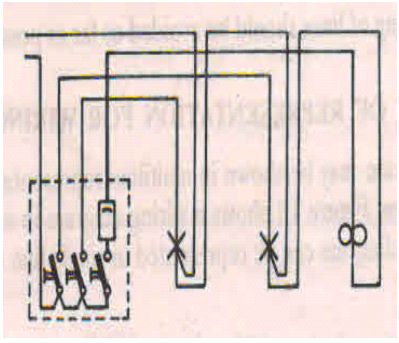
Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any TEN of the following:**	**20 Marks**
a)	**State meaning of following symbols. i)**  **ii)** 	
Ans:	**i)**  : One way two pole switch	**(1 Marks)**
	ii)  : combined switch and socket outlet	**(1 Marks)**
b)	**Define Electrical Installation and give its classification.**	
Ans:	**Meaning of Electrical installation :**	**(1 Marks)**
	Electrical installation is a process of estimation and erection of electrical wiring with materials, and electrical machines used by electricians and electrical engineers for a specific location.	
	Classification of Electrical Installation:	**(1 Marks)**
	i) Internal Electrical Installation : (for example: Any Indoor Installation) ii) External Electrical Installation: (for example: Any Outdoor Installation)	
	OR	

	i) Residential Electrical Installation ii) Commercial Electrical Installation iii) Industrial Electrical Installation
c)	**Draw the symbols of the following. i) Exhaust fan ii) 15A socket outlet.**
Ans:	**i) Exhaust fan :** **ii) 15A socket outlet.** **(Each Symbol: 1 Mark)**  
d)	**Define service connection and state types connection and state types of overhead service connection**
Ans:	**Service Connection:-** **(1 Marks)** It is the input conductor or wire which is carried out from supply company (authorities) pole to consumers' main board or premises. **Types of overhead service connection:** **(1 Marks)** 1. 1-Ph overhead service connection 2. 3-Ph overhead service connection **OR** 1. Overhead service connection with Bare conductor 2. Overhead service connection with weather proof cable
e)	**Why underground service connections are service connections are costly than overhead service connection**
Ans:	**Reason:** **(2 Marks)** Underground service connection is given by underground cable. This cable is costly than bare conductor. Sometimes cable trench is required for cable laying, which requires additional cost. So underground service connections are costly than overhead service connection.

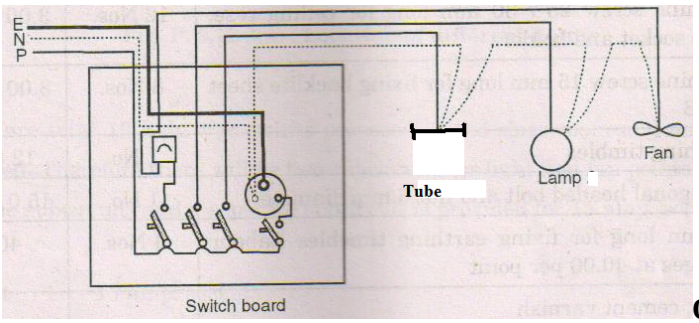
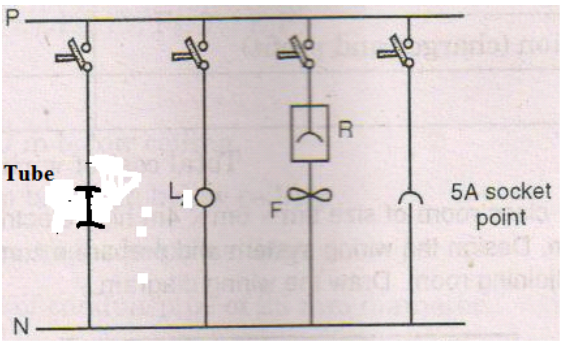
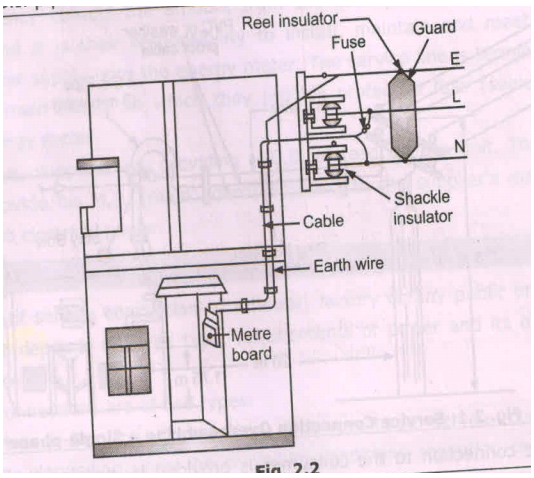
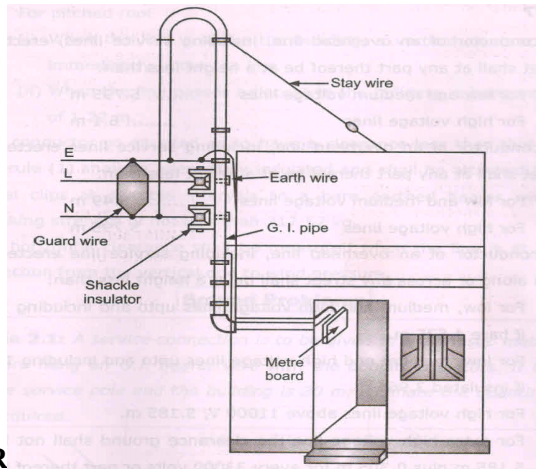
f)	**State function of i) Ceiling rose ii) Conduit**
Ans:	**Function of Ceiling rose:** Output connection for ceiling fan or tube. **(1 Marks)** **Function of Conduit** – To run the wires from switch board to appliances. **(1 Marks)**
g)	**Draw wiring diagram for 2 lamp and one fan controlled by individual switch.**
Ans:	**Wiring diagram for 2 lamp and one fan controlled by individual switch** **(2 Marks)**  or equivalent figure
h)	**State function of Busbar and which material is used for busbar?**
Ans:	**Function of Busbar Bus-bar**: - **(1 Marks)** ➢ Distribute the load on 3-phase four wire systems. ➢ To provide number of connection of incoming line and to provide easy way to connect number of sub circuit. ➢ For better firm connection. ➢ To provide easy access during inspection & maintenance. ➢ To avoid unauthorized changes or connection OR Incoming and outgoing lines are connected to the element. This element means busbar **Material is used for busbar:** **(1 Mark)** 1. Copper 2. Alluminium
i)	**State examples of commercial installation.**
Ans:	**(Any Two types are expected: 1 Mark each)** **Examples of commercial Installation: (Any four examples expected)** 1) Hospital 2) Schools

	3) Colleges 4) Banks 5) Shopping malls 6) Large temples 7) Auditorium 8) Cinema theaters 9) Show-rooms etc.
j)	**State starters used for i) 3-Ph squirrel cage induction motor (3HP) ii) D.C. motor**
Ans:	**Name the starters used for following motors :** **(Each Name of Starter : 1 Mark)** **i) 3 H.P. 3-Ph squirrel cage I.M:** i) DOL starter OR ii) Star-Delta Starter OR ii) Auto transformer starter OR iii) Soft start starter. **ii) D.C Shunt Motor :** 1) Armature resistance starter (Three Point Starter) OR 2) Four Point Starter
k)	**State function of starter and ELCB. (Earth Leakage Circuit Breaker)**
Ans:	**i) Function of Starter:-** **(1 Mark)** 1. To prevent the high starting current OR to minimize the starting current. 2. To give supply failure protection 3. To give over load and short circuit protection **ii) Function of ELCB (Earth Leakage Circuit Breaker):-** **(1 Mark)** ➢ An Earth Leakage Circuit Breaker (ELCB) is a device used to directly to detect earth fault current from an installation and cut off the circuit from power supply and avoid electrical shock to the person.
l)	**Define contract and state its types.**
Ans:	**Definition of Contract:-** **(1-Mark)** The agreement between two parties under some specific terms and conditions is known as contract.

	Types of Engineering contract:- **(Any Two types expected : 1/2-Mark each)** 1) Lump sum contract 2) Item rate contract 3) Cost + % rate contract 4) Target rate contract 5) Material supply contract 6) Labour contract 7) Sub contract 8) All in one contract 9) D.G.S. of 'D' rate contract 10) Cost plus(+) percentage variable rate contract 11) Cost plus(+) fluctuating fees rate contract 12) Cost plus(+) fix fee contract
Q.2	**Attempt any FOUR of the following: 16 marks**
a)	**State any four general rules for Electrical Installation.**
Ans:	**(Note: Similar to following rules any eight expected 1/2 Mark each point)** **Following General rules for Electrical installation:-** 1. Every installation is to be properly protected near the point of entry of supply cables by a two-pole linked main switch and a fuse unit. In a two wire installation if one pole is permanently earthed, no fuse, switch or circuit breaker is to be inserted in this pole. A 3-pole switch and fuse unit is to be used in 3-ph supply. 2. The conductors used are to be such that size of conductor should carry rated current and partial over load current safely. 3. The conductors installed are to be safe in all respects. 4. Every sub-circuit is to be connected to a distribution fuse board. 5. Every line (phase or positive) is to be protected by a fuse of suitable rating as per requirements. 6. A switch board is to be installed so that its bottom lies 1.25 to 1.5 meters above the ground floor. 7. A plugs and socket-outlets are to be of 3-pin type, the appropriate pin of socket being connected permanently to the earthing system. 8. All incandescent lamps, unless otherwise required, are to be hung at a height of 2.5 meters above the floor level. And ceiling fans are to be hung 2.75 meters above the floor.

9. Lights and fans may be wired on a common circuit. Each sub-circuit is not to have more than a total ten points of lights, fans and socket-outlets. The load on each sub-circuit is to be restricted to 800 watts.
10. No fuse and switch is to be provided in earthed conductor.
11. Every circuit or apparatus is to be provided with a separate means of isolation such as a switch.
12. All circuit or apparatus requiring attention are to be provided with means of access to it.
13. In any building, light and fan wiring and power wiring are to be kept separate.
14. In 3-Phase, 4-wire installation the load is to be distributed equally on all phases.
15. No additional load is to be connected to an existing installation unless it has been ascertained that the installation can safely carry the additional load and that the earthing arrangements are adequate.
16. Lamp holders used in bath rooms are to be constructed or shrouded in insulating materials and fitted with protective shield and earth continuity conductor is not to be size less than 7/0.915 mm.
17. The metal sheaths or conduits for all wiring and metal coverings of all consuming apparatus or applications is to be properly earthed in order to avoid danger from electrical shock due to leakage or failure of insulation.
18. Each sub-circuit is to be protected against excessive current (that may occur either due to over load or due to failure of insulation) by fuse or automatic circuit breaker.
19. All light conductors are to be insulated or otherwise safe guarded to avoid danger.

    After completion of work the installations are to be tested (the test are to be carried out as described) before energisation.
20. Earth Resistance :should be very low for domestic installation it should be equal to or less than 5 ohm to 8 ohm
21. Insulation Resistance between conductor : should be very high for domestic installation it should be equal to or more than 1 mega ohm or it should be not be less than $= \frac{50\ M\Omega}{Number\ of\ outlet}$

b)	**Draw wiring and schematic diagram for one fluorescent tube, one lamp, 1 ceiling fan and one 3-pin socket (100 watts)**
Ans:	**(i) Wiring diagram in looping in system:** **(2 Marks)**  **OR** **ii) Schematic Diagram :** **(2 Marks)** 
c)	**Draw neat sketch of bare conductor operated service connection.**
Ans:	**Sketch of bare conductor operated service connection :** **(4 Marks)**  **OR**  equivalent figure

d) State various types of Wiring Residential Electrical Installation and compare them. (Any four points)

Ans:

(Any four types are expected: 1/2 Mark each)

List the types of Internal wiring in residential installations –

1) Cleat wiring
2) Batten wiring
3) Wooden casing capping wiring
4) PVC conduit wiring
5) PVC casing capping wiring
6) Concealed wiring

Comparison of Types of wiring : **(Any Two Point expected: 1 Mark each)**

S.No	Cleat Wiring	Batten Wiring	Wooden Casing Capping	PVC conduit wiring	PVC casing capping wiring	Concealed Wiring
1	**Appearance :**					
	Not Good	Not so good	Good	Good	Good	Better
2	**Cost :**					
	Very Cheap	Cheap	Costly	Moderate	Costly	Very costly
3	**Maintenance :**					
	More	Moderate	Moderate	Less	Less	Less
4	**Fault Finding :**					
	Easy	Easy	difficult	difficult	Less difficult	Very difficult
5	**Life :**					
	Very Less	Moderate	More	More	More	More

e) Explain design of number of lighting sub-circuits with example for residential installations.

Ans:

Number of lighting sub circuits are determined in residential Installation

Lighting Circuit :- **(2 Mark)**

- Each sub circuit should not have more than total 10 points (including lights, fans and 5A socket outlet)

- Each sub circuit should not exceed 800 watts.
- Make the no. of lighting sub circuit for lighting load.

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ lighting\ load}{800\,W}$$ **OR**

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ point}{10}$$

For Example :- **(2 Mark)**

A house has 1200 Watt load and 14 points then from above criteria no. of sub circuits are Two.

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{1200}{800\,W}$$

$$No.\ of\ \ Lighting\ \ Sub\ circuits = 1.5 \cong 2\ \ Nos$$

OR

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{14}{10} = 1.4 \cong 2\ \ Nos$$

Therefore two sub circuits are made.

f) State criteria for selection of contractor. (Any 4)

Ans: **Following the criteria for selection of contractor:**

(Any Four points are expected: 1 Mark each)

1. Contractor should be well reputed
2. Past experience of the Contractor
3. Contractor licenses should be valid
4. Works in hand of the Contractor.
5. Manpower, Machines, Material availability of the contractor.
6. Tax clearance certificate & financial power of contractor.

Q.3	Attempt any FOUR of the following: 16 marks
a)	**Prepare schedule of material for underground service connection.**
Ans:	**Schedule of material for underground service connection:** **(Any Eight point expected: 1/2 mark each point)** 1. 2.5 Sqmm, 4 core Armored cable: (**Size of cable is depends on load & length of cable is depends on service connection premises)** 2. Brick, soft sand for protection of cable. 3. If cable is laid across the public road then Cement pipe, DWC pipe or GI pipe is required for better protection of cable 4. Cable lug as per required size. 5. Cable Gland as per required size 6. Feeder piller or cable box or bus bar and cable end box. 7. GI pipe as required size. 8. Cable bushing. 9. 8 SWG Wire 10. Clamps, saddles etc 11. As such all service connection material like main switch, MCB, Energy meter, Neutral link, IC cut out, earthing set, nut, screws, and wooden board. etc
b)	**Explain selection of main switch and distribution board for residential Electrical Installation.**
Ans:	**Following the procedure for the selection of rating of main switch and distribution board in residential building installation:** **Given Data: (All data is assumed it may vary or it may not be available, there will be only steps and this steps are expected) (Give stepwise Marks as mention below)** $Total\ \ load\ in\ \ = tubes \times watt\ \ = 4 \times 60 + 3 \times 100 = 540\,W$ $= Fans \times watt\ \ = 4 \times 60 = 240\,W$ $= Sockets\ \times\ watt = 6 \times 60 = 360\,W$ i) $Total connected lighting load in a house = 540 + 240 + 360 = 1140 W\ or\ 1.14 KW$, **- (1/2 Mark)** ii) $Total\ connected\ \ Power\ load\ \ in\ a\ house = 4 \times 1000 = 4000 W\ or\ \ 4.0\ KW$, **(1/2 Mark)**

	Total load connected = 1140 + 4000 = 5140 *or* 5.14 *KW* iii) Total load in $= \frac{1140}{800} = 1.425 \cong 2$ Nos lighting sub circuit *Total load in* $= \frac{4000}{2000} = 2$ *Nos Power sub circuit* **Distribution Board**: So, 4 number of MCB are required ---------- **(1 Mark)** iv) Total Connected load is 5140 watt, so Number of sub circuit = 4 Nos. **v) Current rating of iron clad main switch** = since more current is 23 A. Current rating **Iron clad Main switch** = 32 A ---------- **(1 Mark)** **vi) Value of current rating of iron clad main switch:** ---------- **(1 Mark)** **So Use: -** 250V, 32A, ISI mark Main switch of any company
c)	**State stepwise design procedure for residential electrical installation.**
Ans:	**(Note: Similar steps to be followed for design procedure for residential electrical installation)** **(Any Eight types expected: 1/2 Mark each point)** **Following stepwise design procedure for residential electrical installation:-** 1) Find out the total electrical load for the given residential installation. 2) Differentiate this total electrical load in lighting load and power load. 3) Make the no. of lighting sub circuit for lighting load. $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ lighting\ load}{800\ W}$ **OR** $No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ point}{10}$ 4) Make the no. of power sub circuits for power load. $No.\ of\ \ power\ \ Sub\ circuits = \frac{Total\ \ electrical\ \ power\ \ load}{1000\ W\ \ or\ \ 2000\ W}$ **OR** $No.\ of\ \ power\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ points}{1000\ W\ \ or\ \ 2000\ W}$ 5) Find out total power consumption of every lighting and power sub circuits. 6) Find out rated Input current for every lighting and power sub circuit. P = V1 $\cos\phi$ P = Input power for every sub circuit

V = voltage = 230 V

I = Input current for every sub circuit

7) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.
8) Draw the single line diagram.
9) Mark the batten on plan layout.
10) Find out the total length of batten or (conduit) required for every sub circuit and whole residential installation.
11) Find out the total length and size of wire required for every sub circuit.
12) List out the material required for whole residential installation.
13) Find out cost of material and labour in estimation chart.
14) Find out the total cost of estimation with profit margin and contingencies charges.
15) Find out per point charges.
16) Draw the circuit diagram.

d) State difference between residential electrical installation and commercial electrical installation. (Any four)

Ans: **(Any four point expected :Each points : 1 Mark)**

S.No	Basis	Residential Electrical Installation	Commercial Electrical Installation
1	Load capacity	Less	High
2	Input Supply	Generally single phase	Generally 3 phase
3	Purpose	Domestic purpose	Commercial purpose
4	Type of Load	Lighting load is more, power load is less.	Power load is more, lighting load is less.
5	Distribution	Bus bar chamber is not required.	Bus bar chamber is required.
6	Safety precautions	It is not public place so as per our convenience fuse or MCB can be used.	It is public place so fuse MCB, MCCB should be compulsory used.
7	Sub-circuit	The lighting sub-circuit and power sub-circuit are separated	The lighting sub-circuit and power sub-circuit are separated
8	Power factor improvement	There is no need of power factor improvement device	If the power factor is poor then there is need of power factor improving device
9	Caution	There is no need of caution notice for residential installation	If supply voltage is equal to or more then 400V then there is need of caution notice

e)	**State any four general guidelines for Industrial installation.**
Ans:	**(Minimum Eight point expected: 1/2 each point)**

Following general guidelines for Industrial installation:-

1) Find out output power of every machine in watts.
   1) 1 HP = 735.5 w
   2) 1 BHP = 746 w
   3) 1 KVA = 1000 VA. Assume P.f.
2) Find out Input power of every machine by assuming the efficiency of every machine.

$$\text{Input power of machine} = \frac{\text{output power of machine}}{\text{Efficiency of machine}}$$

3) Find out Input current of every machine for 1-ph machine.

$$\text{Input power} = V I \cos\phi$$

V = Input voltage = 230V

$\cos\phi$ = P.f.

I = Input current

If the machine is 3-ph

$$\text{Input power} = \sqrt{3}\ V_L I_L \cos\phi$$

V_L = Line voltage = 400V

I_L = Line current or Input current

$\cos\phi$ = P.f.

4) Find out size and core of cable required for every machine .size of cable is decided by starting current. Which is assumed two times Input current to sustend starting surge, overload momentary short circuit and future expansion.
5) Find out total Electrical load of given factory.
6) Determine the Input current required for whole factory.

$$P = \sqrt{3}\ V_L I_L \cos Ø$$

7) Determine the size & core of Input cable required for whole factory. To decide the size of current is assumed two times rated Input current for future expansion, overload starting surge and momentary short circuit.
8) List out the material required for factory electrification.

9) Make the estimation chart for material and labour also.

10) Find out total cost of estimation by assuming contingencies changes and profit margin.

OR

Following general guidelines for Industrial installation:-

i) Input current of the motor

ii) Selection of size of cable and conduit

iii) Determination of rating of fuse

iv) Selection of rating of main switch

v) Distance between Main board and control board

vi) Type of supply for every machine

vii) Earthing type and its size.

f) State rating in watts, cost and name of manufacturer company for following electrical point used in residential Installation

Ans: **(4 Marks)**

S.No	Material name	Watts	Cost	Manufacturer
i)	Fluorescent Tube	28w,36w, or 40 watt	Rs. 40/- to 50/-	Crompton Greeaves, Philips, Bajaj,GE, Anchor etc
ii)	Ceiling Fan	60 watt	Rs. 1500/- to 2500/-	Crompton Graves, Philips, Bajaj, havalles,, Usha, etc
iii)	15A Socket outlet	1000 watt	Rs. 30/- to 60/-	Anchor, Vinay, Great white, Leggards, etc

Q.4 Attempt any FOUR of the following: 16 marks

a) How rating of main switch and cable is selected for Industrial Installation.

Ans: **(Reason of main switch:2 Marks & Reason of cable : 2 Mark)**

1. Rating of Main Switch or Fuse Rating is decided in industrial installation:

- Rating of main switch or fuse is based up the starting current of motor.
- For calculating starting current is considered 2 times that of full load current,. Thus main switch is decided.
- If number of motors are there, then main switch is decided from following

formula.

Incoming current = Starting current of highest rated m/c + Full load current remaining all m/c

Thus from incoming current main switch is decided

2. Cable Rating is decided considering following points in industrial installation:

- The current rating of cables for supply to motor is based up on the normal full load current of motor considering the overload capacity 50%
- We take 1.5 times the rated current or full load current. & thus cable rating is decided.

b) Draw Installation plan and calculate length, load of phase wire for given installation in Fig. No. 1 having 3 ceiling fan, 3-fluorescent tubes, four 3-pin socket (6A) and 3 lamps.

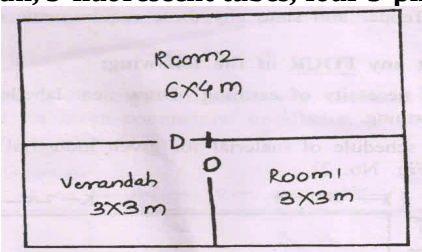


Fig. No. 1

Ans: **(Quantity of Material for wire and casing capping may vary according to student layout)**

$$Total\ \ load\ in\ \ Installation = tubes \times watt\ \ = 3 \times 40 = 120\,W$$

$$= Fans \times watt\ \ = 3 \times 60 = 180\,W$$

$$= Plug \times watt\ \ = 4 \times 100 = 400\,W$$

$$= Lamps \times watt\ \ = 3 \times 100 = 300\,W$$ ---------- **(1/2 Mark)**

$$Total\ load\ in\ \ Hall = tubes\ in\ Watt + Fans\ in\ \ Watt + Lamps\ in\ WC\ \&\ Bath$$

i) $Total\ load\ in\ \ Installation = 120 + 180 + 400 + 300 = 1000$ *watt* -

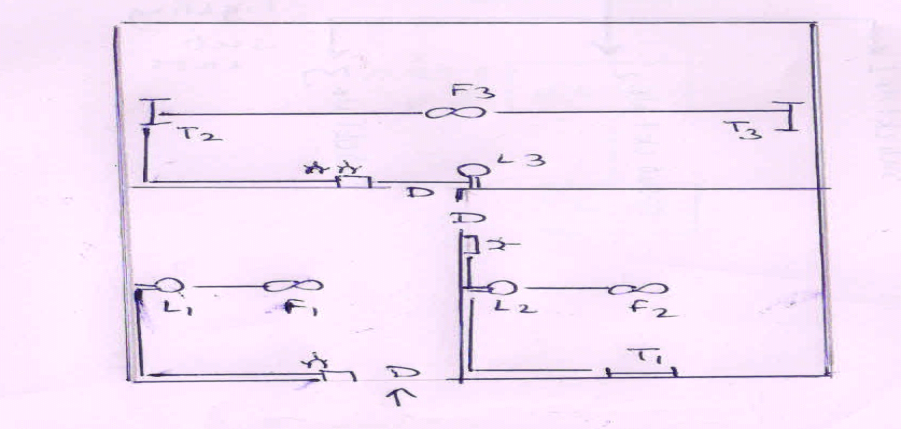
$$Total\ load\ in\ \ Amps = \frac{1000}{230} = 4.347 \cong 5\ Amp$$ --- **(1/2 Mark)**

So Use:- ---------- **(1/2 Mark)**

230V, 16A, ISI mark Main switch of any company and lighting load 1000 watt & 13 points.

Therefore Two sub circuit is required

Installation Plant: **--- (1/2 Mark)**



Assumption :

Switch board is at a height of 1.5 Mtr from ground level

Conduit run at a height of 3 Mtr from ground level, considering height of ceiling 4 Mtr

Length of the Casing Capping or neutral wire: **--- (1 Mark)**

$$= \text{Varanda h}(\overset{V}{1.5}+\overset{H}{2}+\overset{H}{1.5}+\overset{V}{1}+\overset{V}{1.5}) + \textit{Room No.}1(\overset{V}{1.5}+\overset{H}{2}+\overset{H}{1.5}+\overset{V}{1}+\overset{H}{1.5}) + \textit{Room No.}2\,(\overset{H}{3}+\overset{H}{2}+\overset{V}{1}+\overset{H}{6}+\overset{V}{1}) + 10\%$$

$$= 7.5 + 7.5 + 13 + 10\%$$

$$= 28 + 10\%$$

$$= 28 + 2.8$$

$$= 30.8 \approx 31\ Mtr$$

Length of the Casing Capping = Length of neutral wire

Length of neutral wire = 31 Mtr

As per thumb rule in neutral loop system Phase wire is double that of neutral wire: **--- (1 Mark)**

Length of Phase wire $= 31 \times 2$

$= 62\ Mtr$

Total length of wire = 3 x Length of Batten (as per the thumb rule in neutral loop-In system)

= 3 x 31

Total length of wire = 93 Mtr

c)	**State stepwise design procedure for commercial installation.**
Ans:	**(Minimum Eight point expected: 1/2 each point)**

The following design procedure for commercial installation:

1) Find out the type of load and total electrical load for the given commercial installation.
2) Differentiate this total electrical load in lighting load and power load.
3) Make the no. of lighting sub circuit for lighting load.

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ Electrical\ \ lighting\ \ load}{800\ W}$$

OR

$$No.\ of\ \ Lighting\ \ Sub\ circuits = \frac{Total\ \ No.of\ \ lighting\ \ point}{10}$$

4) Make the no. of power sub circuits for power load.

$$No.\ of\ \ power\ Sub\ circuits = \frac{Total\ electrical\ \ power\ load}{2000\ W\ \ or\ 3000\ W}$$

OR

$$No.\ of\ \ power\ Sub\ circuits = \frac{Total\ \ No.of\ \ power\ \ points}{2000\ W\ \ or\ 3000\ W}$$

5) Find out total power consumption of every lighting and power sub circuits.
6) Find out rated Input current for every lighting and power sub circuit.

$P = V1 \cos\phi$ P = Input power for every sub circuit
V = voltage = 230 V
I = Input current for every sub circuit

7) Determine the size of wire required for every sub circuit by considering overload starting surge and future expansion.
8) Draw the single line diagram.
9) Mark the batten on plan layout.
10) Find out the total length of batten required for every sub circuit and whole commercial installation.
11) Find out the total length and size of wire required for every sub circuit.
12) List out the material required for whole commercial installation.
13) Find out cost of material and labour in estimation chart.
14) Find out the total cost of estimation with profit margin and contingencies charges.
15) Find out per point charges.
16) Draw the circuit diagram.

d) Explain terms earnest money deposit and security deposit.

Ans:

i) Earnest Money deposit (EMD) :- **(2 Marks)**

EMD is a deposit taken as a guaranty from the bidder if the tender is accepted by the owner and if the contractor (bidder) refuses to accept that work in that case the EMD is not returned to that party it is generally 2 to 5 percent estimated cost. It is refundable to every unsuccessful (not considered) bidder

ii) Security Deposit (SD):- **(2 Marks)**

Security deposit is amount or deposit given by the contractor to the owner till satisfactory completion of the project work. Generally it is a 5 to 10 % of the total estimated cost.

.

e) Compare industrial electrical installation and residential electrical installation. (any four)

Ans:

(Any Four Point expected : 1 Mark each)

S.No	Basis	Industrial Electrical Installation	Residential Electrical Installation
1	**Location**	In industrial estate or MIDC area	Highly population density area
2	**Cost**	More	Less
3	**Precautions**	All precautions should be taken	All safety precautions should be taken
4	**Supply**	Generally 3-ph, 400V AC supply is provided	Generally 1-ph, 230V AC supply is provided
5	**Tariff**	Tariff for industrial load is different	Block rate tariff is applied

f) State functions of ; i) Cable box ii) Guard wire iii) Shackle insulator iv) Stay wire used in service connection

Ans:

(Function of following point : 1 Mark each)

i) Function of Cable box: To hold and inspect incoming and outgoing terminals

ii) Function of Guard wire :

A grounded conductor placed beneath an overhead transmission line in order to ground the line, in case it breaks, before reaching the ground.

iii) Function of Shackle insulator:

Used of shackle insulator always on distribution systems the main function of an insulator is support and insulate.It is at corner or end points.

iv) Function of Stay wire used in service connection:

To give mechanical Support to pole, line and prevent leakage current if any

Q.5 **Attempt any FOUR of the following:** **16 marks**

a) **A shop of size 4 x 6m is to be provided with 14 fluorescent tubes each 40 Watts, 06 ceilling fans each 60 watts and 06 5Amp three pin sockets 100 watt.**
i) Draw Installation Plan ii) Select the distribution Board for given load.

Ans:

Note: Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

Given Data: (The Assumed data may be vary (Give stepwise Marks as mention below)

$Total\ \ load\ in\ \ Hall = \ \ tubes\ (14 \times 40\ watt)\ = 560\ W$

$= Fans \times watt\ = 06 \times 60 = 360\ W$

$= Plug \times watt\ = 6 \times 100 = 600\ W$ ------ **(1/2 Mark)**

$Total\ load\ in\ \ Hall = tubes\ in\ Watt + Fans\ in\ \ Watt + \ plug\ in\ Watt$

i) $Total\ load\ in\ \ Hall = 560 + 360 + 600 = 1520\ watt$ ---------- **(1/2 Mark)**

$Total\ load\ in\ \ Amps = \frac{1520}{230} = 6.608 \cong 7\ Amp \quad assu\min g\ \ p.f. = 1$ ---- **(1/2 Mark)**

ii) $No.\ of\ \ Sub\ circuit\ = \frac{1520}{800} = 1.9 \cong 2\ \ Nos\ lighting\ sub\ circuit$ ---------- **(1/2 Mark)**

$According\ to\ po\text{int}\ No.\ of\ \ Sub\ circuit\ = \frac{26}{10} = 2.6 \cong 3\ \ Nos\ lighting\ sub\ circuit$

Therefore no of sub circuits are 3

iii) Rating Main switch and Distribution Board: -

since rated input current is 16 A. ---------- **(1/2 Mark)**

Assumed that Staring current = 1.5 times rated current

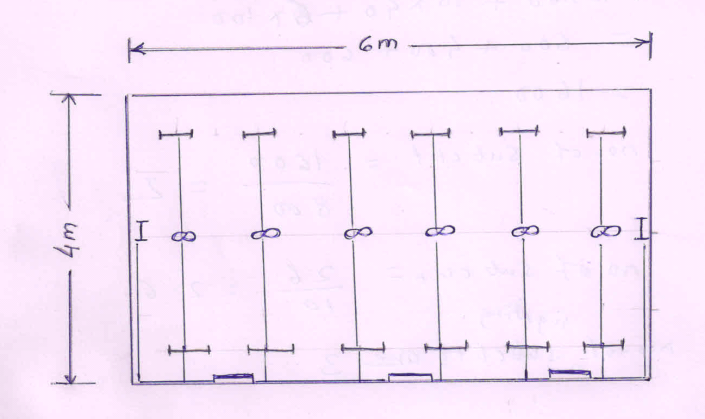
So starting current = 1.5x 7 = 10.5 A

So Use:- ---------- **(1/2 Mark)**

230V, 16A, ISI mark Main Switch of **any company**

3 way distribution board of any make.

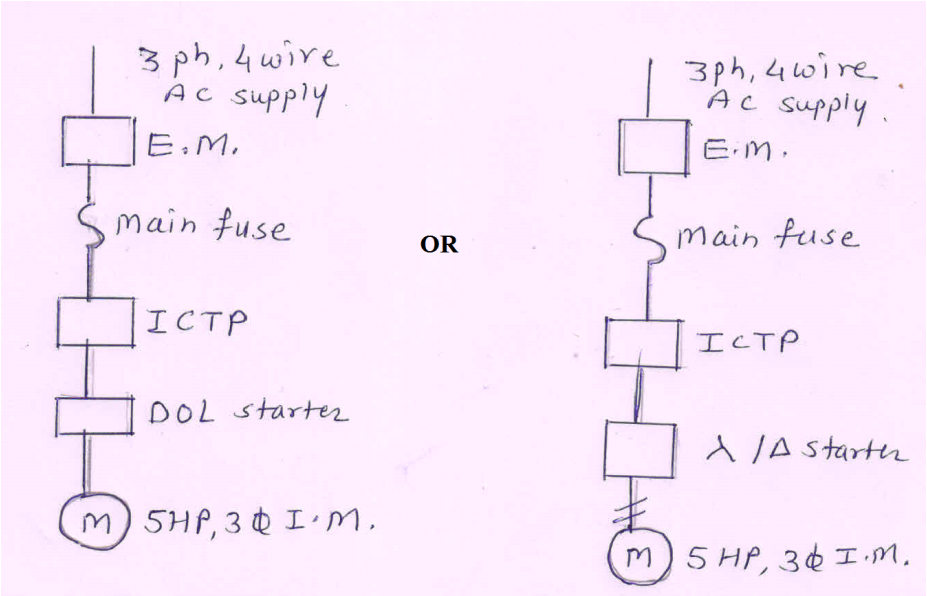
1) layout and show the position of lamps, fans etc: ---------- **(1 Mark)**



Or equivalent diagram

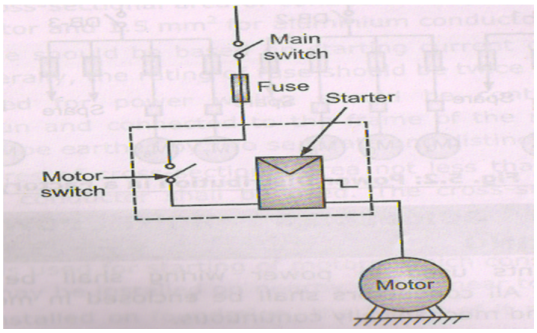
b) **Draw single line diagram with labelling for 5HP 3-Ph, 440 V, Induction motor to be operated on suitable starter.**

Ans: **Single line diagram 5 Hp, three phase, 440V, Induction motor -** **(4 Mark)**



Or equivalent ckt dia.

Wiring diagram –



or equivalent figure

c) Explain selection of starters for Industrial Installation.

Ans: **selection of starters for Industrial Installation:**

- Every motor must be provided with a starter to start and stop the motor.
- It shall be within the sight of a person at the motor. It shall be so arranged as to be easily operated by the person in the control of motor.
- Different types of starters used for various HP rating motor.

Up to 5HP ----------DOL starter

5 HP to 15 HP----------Star/Delta starter

Above 15 HP----------Auto transformer starter

Slip ring I.M.----------Rotor resistance starter

d) Explain procedure for submission of tender.

Ans: **Procedure of submission of Tender:-** **(4 Marks)**

- The tender is submitted from party No.2 (Bidder) to party No.1 (Owner) in sealed envelopes within the specification date & time period.
- The is submitted in envelops No.2 titled by envelop No.1 & envelop No.2.
- The content in every envelope is given as below

OR

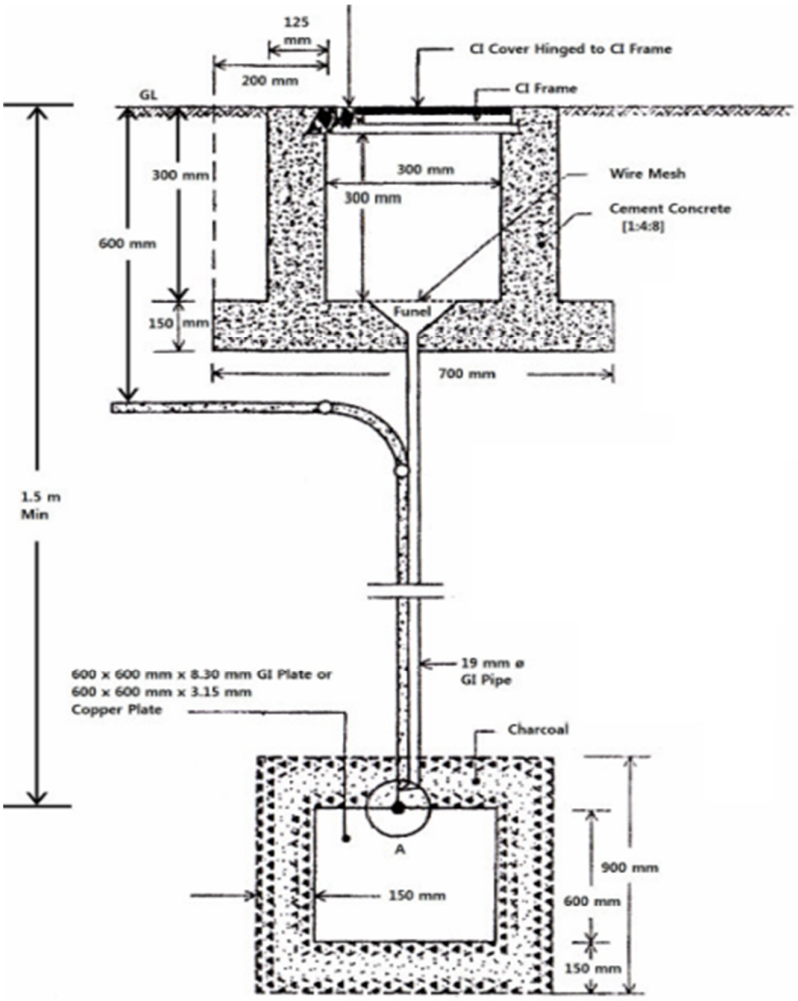
- The system of submitting tender documents is also called as two envelope system.
- The treasury challan, deposit, call receipt, forwarding letter the copies of registration certificate, income tax clearance certificate, and list of machinery to be used to be sealed in one envelope.
- The tender set itself with quoted value should be sealed in another envelope: these two sealed envelopes should again be put in one coverer and sealed. On the top of this cover, the name of the work, address of the receiving authority should be written. These envelopes are then handed over in person or send by post to the address mentioned before the specified time and date

	OR ➢ According to old procedure three envelopes are there and in third envelope rate offered by the tenderer is given and it is mention as **" Envelop No.3"**
e)	**State factors deciding size of busbar chamber for commercial installation.**
Ans:	**Size of busbar chamber depends on following factors.** **(4 Marks)** ➢ Total load or load current on installation ➢ Future load on installation ➢ No. of tappings provided on buabar ➢ Spare feeders provided if any ➢ Size of incoming and outgoing cable ➢ Whether bus bar is outdoor or indoor type **Bus bar chamber is required for larger installation**. The electrical load of commercial installation is large therefore 3-phase 4 wire power service connection is provided to satisfy the requirement of the entire load. Thus to distribute the load on 3-phase four wire system, bas-bar chamber is used. Bus-bar is a copper or aluminum conductor (strip) to which number of inputs and number of outputs can be connected. Incoming and outgoing wires or cables are connected to bus-bar by screw and nut arrangement.
f)	**Define Tender and state any three requirements of valid contract.**
Ans:	**Meaning Tender:-** **(2 Marks)** Tender is offer or invitation of the work between any two parties. This offer may be written or non written. This offer is given by party no.1 (owner) to party no.2 (contractor- who has to complete the project work). **Following requirements of valid contract:** **(Any 4 Point Expected : 1/2 Mark each –Total 2 Mark)** 1. Contract should be written. 2. Contract should be signed by proper witness 3. Contractor licenses should be valid. 4. Contract should be signed by competent authority. 5. Contract should be signed by proper authorized persons. 6. It should be legally challenged in the court.

Q.6	**Attempt any FOUR of the following:** **16 marks**
a)	**What is necessity of earthing? Draw neat labelled sketch of plate earthing.**
Ans:	**Necessity of earthing:** **(2 Marks)**

1. To provide an alternative path for the leakage current to flow towards earth.
2. To save human life from danger of electrical shock due to leakage current.
3. To protect high rise buildings structure against lightening stroke.
4. To provide safe path to dissipate lightning and short circuit currents.
5. To provide stable platform for operation of sensitive electronic equipment.

Diagram for plate earthing : **(2 Marks)**



or equivalent figure

b) Prepare schedule of material for given industrial installation. (Refer Fig. No. 2)

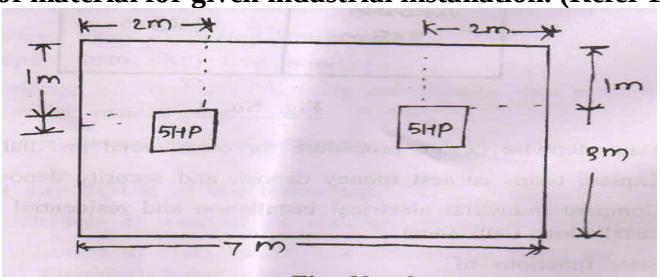


Fig. No. 2

Ans: **(Costing of material is not required marks are only allotted for Material list: 4 Point Expected Each Point: 1 Marks –Total 4 Marks)**

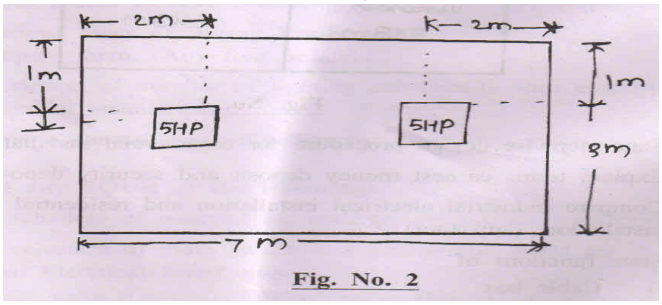


Fig. No. 2

i) Rating for 5 HP, 3-Ph I.M :-

$$Total\ power = Total\ H.P \times 735.5$$

$$Total\ power = 5\ HP \times 735.5 = 3677.5\ watt$$

$$Total\ power = 3677.5\ watt$$ ------ **(1/2Marks)**

$$Rated\ input\ current\ I_L = \frac{HP \times 735.5}{\sqrt{3}\ V_L \times \eta \times Cos\phi}$$ ------ **(1/2Marks)**

$$Rated\ input\ current\ I_L = \frac{3677.50}{\sqrt{3} \times 415 \times efficency \times P.f}$$

$$Rated\ input\ current\ I_L = \frac{3677.50}{\sqrt{3} \times 415 \times 0.85 \times 0.85}$$

$$Rated\ input\ current\ I_L = 7.081\ Amp$$ ---- **(1/2 Marks)**

Starting current = 2 x 7.081 = 14.162 Amp

So use, 4 Sqmm , 4 core cable copper cable , 500V grade should be selected rating of SFU, ICTP switch is 30A, 450V grade should be selected. - **(1/2 Marks)**

Schedule of Material : **(2 Marks)**

S.No	Material of Material	Quantity	Cost of material
1	32 A Busbar with Netural link	01	1750.00
2	3-ph,4 wire 415V, 15-30A, A.C. supply Energy Meter	01	500.00
3	ICTP 450V ,30A	03	750.00
4	Star Delta Starter OR DOL starter	02	4000.00
5	8 SWG Earthing Wire	0.5.kg	225.00
6	60 cm x 60cm x6.36 mm Copper Earthing Plate	01	450.00
7	Earthing nut-boalt	04	35.00
8	Earthing Sundry	lumsump	3500.00
9	12x12 Wooden Board for SDB	03	75.00
10	Screw 3 inch length	18 No	30.00
11	Screw 1 inch length	10 No	15.00
12	R,Y,B Indication Lamp	03	60.00
13	PVC Tape	04	40.00
14	Saddles	1 box	25.00
15	32mm PVC conduit (3 Mtr pipe) 1.5mm thickness	7 pipe	490.00
16	4 Sqmm x 4 Copper aramoured cable	15 Mtr	300.00
18	Junction Box	03 approx.	30.00
19	Lug & gland	06 approx	130.00
20	Labour Charges	Lumsum	3000.00
		Total Amount :-	**15405.00**
21	Contingencies+ profit margin	10% Amount:-	1540.50
		Total Amount:-	**16945.50**
	iii) Cost of work:	Say Total Amount:	16946.00

c) Draw single line diagram (showing main switch distribution board) for commercial installation having 26 lighting points (10 fans, 10 fluorescent tube and six 3-pin socket) of load 1600 watts.

Ans:

Note: Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

Given Data: (The Assumed data may be vary **(Give stepwise Marks as mention below)**

$Total\ \ load\ in\ \ Hall = tubes \times watt\ \ = 10 \times 40 = 400\,W$

$= Fans \times watt = 10 \times 60 = 600\,W$

$= Plug \times watt = 06 \times 100 = 600\,W$ ------ **(1/2 Marks)**

$Total\ load\ in\ Hall = tubes\ in\ Watt + Fans\ in\ Watt + plug\ in\ Watt$

i) $Total\ load\ in\ Hall = 400 + 600 + 600 = 1600\ watt$ ---------- **(1/2 Mark)**

$Total\ load\ in\ Amps = \frac{1600}{230} = 6.95\ Amp \quad assu\min g\ p.f. = 1$ ---------- **(1/2 Mark)**

ii) $No.\ of\ Sub\ circuit = \frac{1600}{800} = 2\ Nos\ lighting\ sub\ circuit$ ---------- **(1/2 Mark)**

$According\ to\ po\text{int}\ No.\ of\ Sub\ circuit = \frac{26}{10} = 2.6 \cong 3\ Nos\ lighting\ sub\ circuit$

No. of Sub circuit = 3, Therefore 3 Way Distribution board is selected.

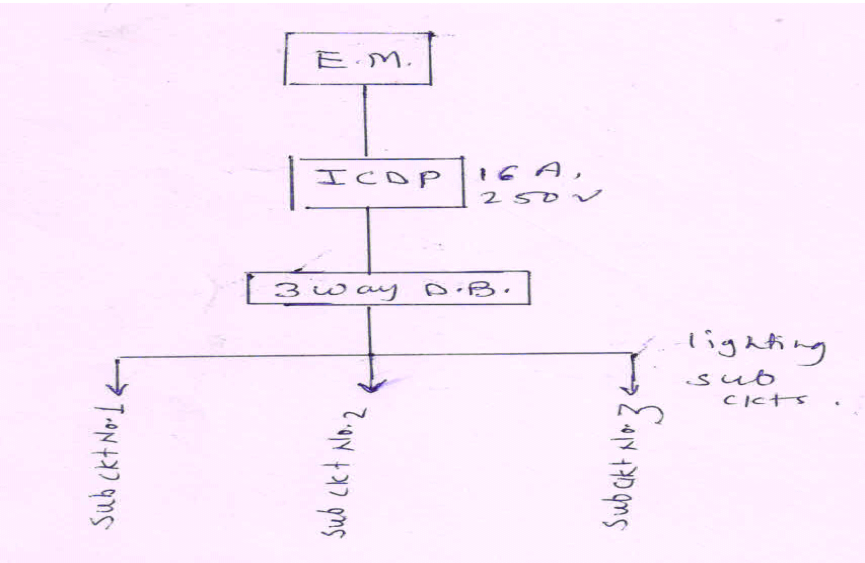
iii) Rating Main switch: - since rated input current is 16 A. ---------- **(1/2 Marks)**

So Use:- ---------- **(1/2 Mark)**

230V, 16A, ISI mark Main switch of any company

Cable selected: 1.5 Sqmm, Copper cable single core

1) Single Line Diagram: ---------- **(1 Mark)**



d)	**State stepwise design procedure for industrial electrical installation.**
Ans:	**(Minimum Eight point expected : 1/2 each point)**

Explanation of design consideration in industrial installation :-

1) Find out output power of every machine in watts.
   1) 1 HP = 735.5 w
   2) 1 BHP = 746 w
   3) 1 KVA = 1000 VA. Assume P.f.
2) Find out Input power of every machine by assuming the efficiency of every machine.

$$\text{Input power of machine} = \frac{\text{output power of machine}}{\text{Efficiency of machine}}$$

3) Find out Input current of every machine for 1-ph machine.

Input power = $V I \cos \phi$

V = Input voltage = 230V

$\cos \phi$ = P.f.

I = Input current

If the machine is 3-ph

Input power = $\sqrt{3}\ V_L I_L \cos \phi$

V_L = Line voltage = 400V

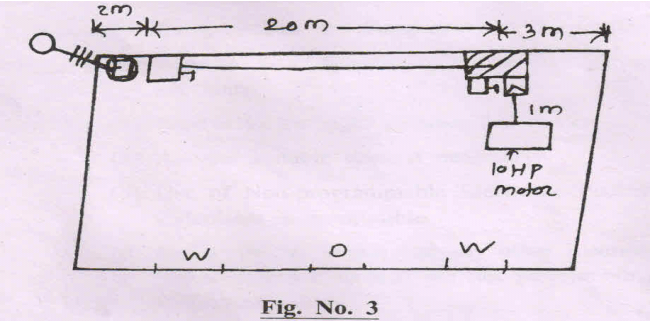
I_L = Line current or Input current

$\cos \phi$ = P.f.

4) Find out size and core of cable required for every machine size of cable is decided by starting current. Which is assumed two times Input current to sustend starting surge, overload momentary short circuit and future expansion.
5) Find out total Electrical load of given factory.
6) Determine the Input current required for whole factory.

$P = \sqrt{3}\ V_L I_L \cos Ø$

7) Determine the size & core of Input cable required for whole factory. To decide the size of current is assumed two times rated Input current for future expansion, overload starting surge and momentary short circuit.
8) List out the material required for factory electrification.

	9) Make the estimation chart for material and labour also. 10) Find out total cost of estimation by assuming contingencies changes and profit margin. OR **Design consideration to prepare estimate for a factory installation:-** vii) Input current of the motor viii) Selection of size of cable and conduit ix) Determination of rating of fuse x) Selection of rating of main switch xi) Distance between Main board and control board xii) Type of supply for every machine xiii) Earthing type and its size.
e)	**Select and calculate length of cable, select rating of main switch, selection and rating of fuse for given industrial installation. (Assume necessary data) (Refer Fig. No. 3)**  **Fig. No. 3**
Ans:	**Note: Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer**. Assuming height of Ceiling if 3 m from the floor. Motor is installed 1 M away from the nearest wall. Height of Main Switch is 1.2 M from the floor **Step No. 1:-** The out power of induction motor = 10 x 735.5 = 7355 W-------- **(1/2 Mark)** **Step No. 2:-** Input power of I. M = output power of I M / efficiency of IM motor.**(1/2 Mark)** Assuming efficiency of I.M is 80 % Input power of induction motor = 7355 / 0.8 = 9193.75 W **Step No. 3:-** To determine the rated current for I.M ---------- **(1/2 Mark)**

$P = \sqrt{3}\, V_L\, I_L Cos\phi$ $V_L = 415\ V$

$$I_L = \frac{P}{\sqrt{3}\, V_L Cos\phi}$$

$$I_L = \frac{9193.75}{\sqrt{3} \times 415 \times 0.8} \qquad Cos\phi = 0.8\ assumption$$

$I_L = 15.98\ Amp$ $Rated\ current = 15.98\ Amps$

Step No. 4:- To determine the size & core of cable:- ---------- **(1/2 Mark)**

Starting current is assumed two times rated input current for starting surge, momentary short circuit & overload. Starting current = 2 x 15.98 = 31.96 Amps

So use,

10 Sqmm 3 core cable for the I.M.

Step No. 5:- Determined the size length & dimensions of ICTP earth wire at input cable:-

The rating of main switch is 450 V, 32 Amp ICTP ISI mark

Size of earth wire 8 SWG copper or 6 SWG GI ---------- **(1 Mark)**

Length of earth wire = 2 times length of cable

Length of input cable for I .M at actual

Length of cable = main board to main switch of motor + main switch to motor foundation

Length of cable = 20 Mtr + 4 Mtr (Starter to motor foundation double run if star-delta starter is used) + 20 % Extra

Length of cable = 24 Mtr + 5 Mtr

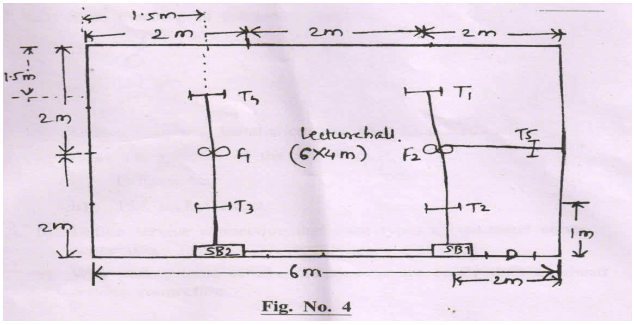
Length of cable = 29 Mtr ---------- **(1 Mark)**

OR

Total length of Cable = 1 Mtr + 1 Mtr +0.5 Mtr + 20 Mtr + 1 Mtr +0.5+1 Mtr+ 1 Mtr+ 0.5 Mtr + 0.5 Mtr +10 %

= 28 Mtr + 10 %

Total length of Cable = 31 Mtr

f)	**Calculate and select length of phase wire, calculate length of neutral wire for given commercial installation. (Assume necessary data) (Refer Fig. No. 4)**  Fig. No. 4
Ans:	**(Quantity of Material for wire and casing capping may vary according to student layout)** $Total\ \ load\ in\ \ Installation = tubes \times watt\ \ = 5 \times 40 = 200\,W$ $= Fans \times watt\ \ = 2 \times 60 = 120\,W$ **---- (1/2 Mark)** $Total\ load\ in\ \ Hall = tubes\ in\ Watt + Fans\ in\ \ Watt$ i) $Total\ load\ in\ \ Installation = 200 + 120 = 320\ \ watt$ ---------- **(1/2 Mark)** $Total\ load\ in\ \ Amps = \frac{320}{230} = 1.39\,Amp$ ---------- **(1/2 Mark)** **So Use:-** ---------- **(1/2 Mark)** 230V, 16A, ISI mark Main switch of any company , 1.5 sqmm single core copper cable used **Length of the Casing Capping:** --- **(1 Mark)** $= 1.5_{V} + 2.5_{H} + 1_{V} + 2_{H} + 1.5_{V} + 1_{V} + 2.5_{H} + 2_{H} + 1_{V} + 10\%$ $= 15 + 10\%$ $= 15 + 1.5$ $= 16.5 \approx 17\ Mtr$ Length of the Casing Capping = Length of neutral wire Length of neutral wire = 17 Mtr

	As per thumb rule in neutral loop system Phase wire is double that of neutral wire: --- **(1 Mark)** **Length of Phase wire** $= 17 \times 2$ $= 34\ Mtr$ **OR** Total length of wire = 3 x Length of Batten (as per the thumb rule in neutral loop-In system) = 3 x 17 Total length of wire = 51 Mtr

----------**END**----------